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NASA TM X-74012

NASA TM X-74012

(NASA-TM-X-74012) LONGITUDINAL AND
LATERAL-DIRECTIONAL STATIC AERODYNAMIC
CHARACTERISTICS OF AN UNPOWERED ESCAPE
SYSTEM EXTRACTION ROCKET MODEL WITH ATTACHED
LAUNCH TUBES (NASA) 26 p HC A03/MF A01

N77-27083

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**LONGITUDINAL AND LATERAL-DIRECTIONAL STATIC AERODYNAMIC
CHARACTERISTICS OF AN UNPOWERED ESCAPE
SYSTEM EXTRACTION ROCKET MODEL WITH ATTACHED LAUNCH TUBES**

by

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and

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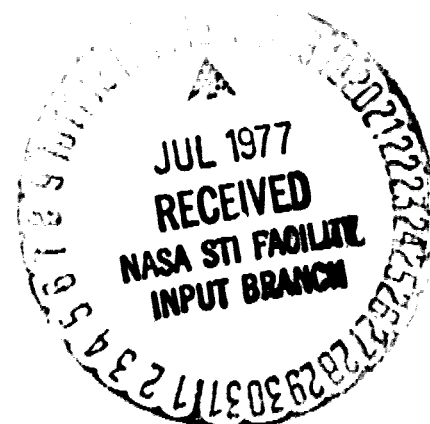
May 1977

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National Aeronautics and
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ABSTRACT

An escape system extraction rocket proposed for use on the Rotor Systems Research Aircraft was tested at Mach numbers of 0.1 and 0.3 through an angle-of-attack range from -2° to 102° and an angle-of-sideslip range from 0° to 15° in the Langley 7- by 10-foot high speed tunnel. The data is presented without analysis in order to expedite publication.

INTRODUCTION

The Rotor Systems Research Aircraft is a combined effort of the U. S. Army and NASA. An emergency escape system for this aircraft was proposed using an extraction rocket for each personnel station. A hot gas launch system attached to the extraction rocket would initiate the separation of the extraction rocket from the aircraft. A wind-tunnel test program was initiated to obtain static aerodynamic data for input to a digital computer simulation of the rocket and extracted crewman trajectory.

It is the purpose of this report to present, without analysis, the static aerodynamic characteristics of this proposed extraction rocket. The investigation was conducted in the Langley 7- by 10-foot high speed tunnel at Mach numbers of 0.1 and 0.3 which correspond to Reynolds numbers, based on model reference diameter, of 0.15×10^6 and 0.475×10^6 , respectively. The angle-of-attack range was from -2° to 102° and the angle-of-sideslip range was from 0° to 15° .

SYMBOLS

The International System of Units, with the U.S. Customary Units presented in parentheses, is used for the physical quantities in this report. (See reference 1). Measurements and calculations were made in the U.S. Customary Units. The data presented in this report are referred to the body axis system as indicated in figure 1.

b	model reference span, .0762 m (.25 ft)
C_A	axial force coefficient, $\frac{\text{Axial Force}}{qS}$
C_l	rolling moment coefficient, $\frac{\text{Rolling Moment}}{qSb}$
C_m	pitching moment coefficient, $\frac{\text{Pitching Moment}}{qSd}$
C_N	normal force coefficient, $\frac{\text{Normal Force}}{qS}$
C_n	yawing moment coefficient, $\frac{\text{Yawing Moment}}{qSb}$
C_Y	side force coefficient, $\frac{\text{Side Force}}{qS}$
d	model reference diameter, .0762 m (.25 ft)
M	free stream Mach number
q	free stream dynamic pressure, Pa(lbs/ft ²)

DESCRIPTION OF MODEL

A full scale unpowered model was used in the study. A drawing of the model is shown in figure 1. Figure 2 presents a photograph of the model mounted in the Langley 7- by 10-foot high speed tunnel. The model consisted of a cylindrical centerbody, which was attached to a strain gage balance, with a nose which incorporated the rocket nozzles and an afterbody with attached launch tubes.

The nose and afterbody could be set at different roll angles relative to the centerbody. Since the centerbody was axisymmetric, the roll attitude of the nose and afterbody was used to define the roll orientation of the model.

Apparatus, Tests, and Corrections

This investigation was made in the Langley 7- by 10-foot high speed tunnel which is a continuous flow atmospheric tunnel. Forces and moments were measured by an internally mounted six-component strain-gage balance. The pitch attitude of the model was measured by an accelerometer mounted within the model. The pressure in the balance chamber was also recorded, however no corrections were made to the data for chamber pressure.

The test was conducted at Mach numbers of 0.1 and 0.3 which correspond to Reynolds numbers of 0.15×10^6 and 0.475×10^6 based on d . The angle-of-attack range was from -2° to 102° and the angle-of-sideslip range was from 0° to 15° .

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Two major test setups were employed during the test. For the angle-of-attack range from -2° to 22° , the combined alpha and beta was obtained using combinations of sting pitch and sting yaw. The sting entered the model through the open base of the model.

The second setup achieved combined alpha and beta using combinations of sting pitch and model roll. This setup divided the pitch angle into three overlapping ranges of 33° to 57° , 55.5° to 79.5° , and 78° to 102° . The model roll angle was chosen for the midpoint of each range. Since the sideslip was achieved through a fixed model roll for each pitch range, the sideslip angle was not constant. The sting entered the model through an opening in the top of the centerbody. The base of the model was plugged; however, no base pressures were measured. Note that the test technique employed for each pitch range was to start with the model at the midpoint of the range, then proceed to the lower limit of the range and take data as the pitch angle was increased to the upper limit of the range.

PRESENTATION OF RESULTS

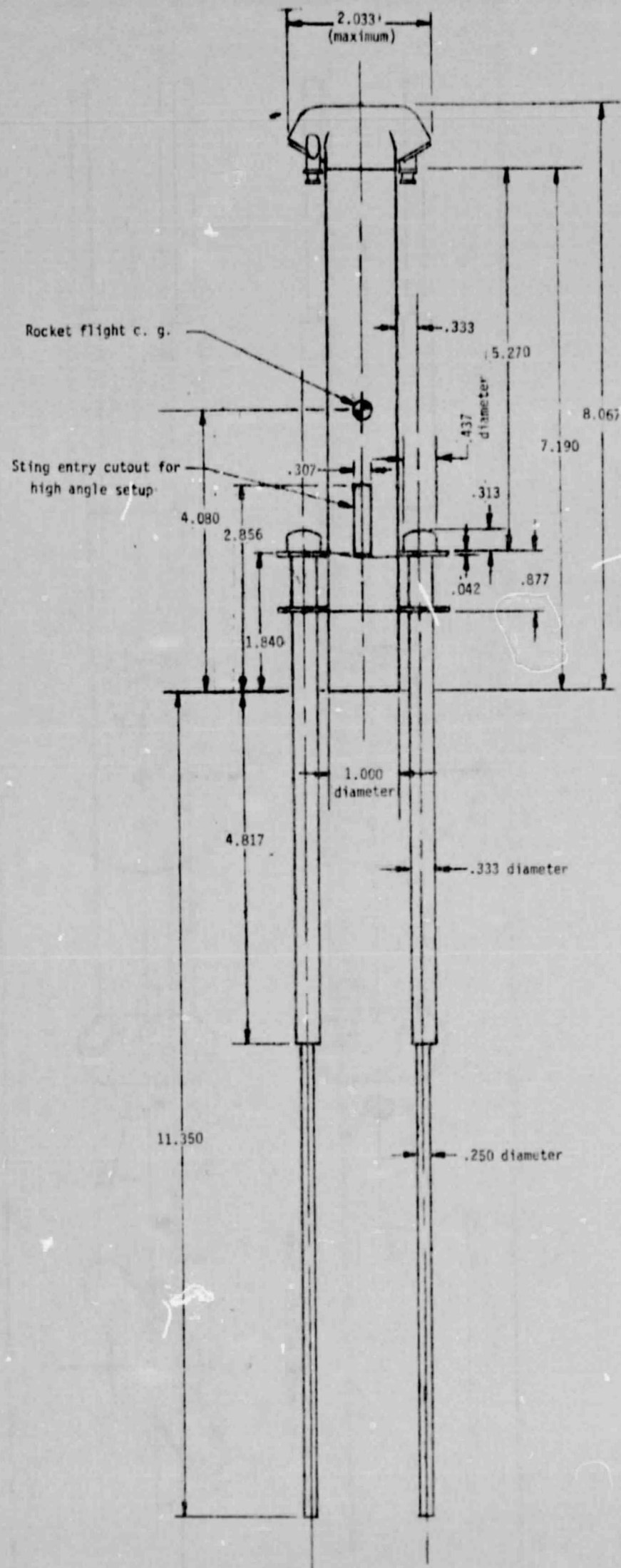
The longitudinal characteristics are presented in figure 3. The lateral-directional characteristics are presented in figure 4. The chamber pressure characteristics are presented in figure 5.

Note that, due to the test technique employed, there may be anomalies between the data in the overlapped pitch range. These anomalies are real and result from the fact that, in one case the overlap region was presumably approached with attached flow on the model, whereas in the other case, the overlap region was presumably approached with separated flow on the model.

The differences between the data at a Mach number of 0.1 and at a Mach number of 0.3 are attributable primarily to Reynolds number effects. (See reference 2.)

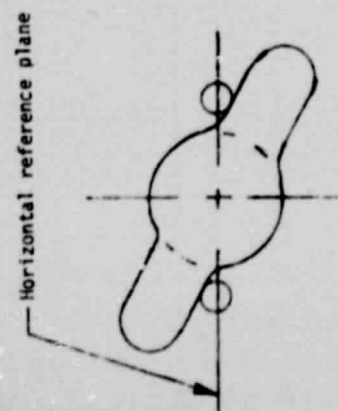
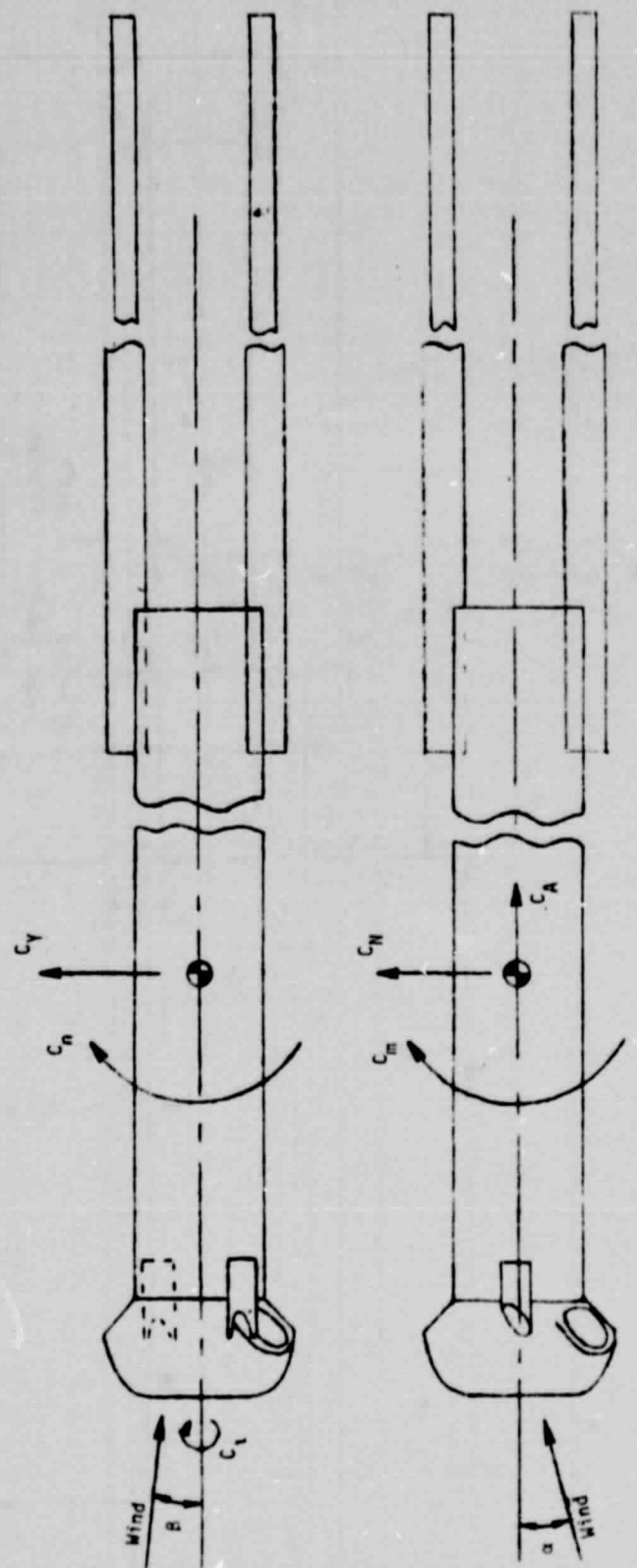
REFERENCES

1. Mechtly, E. A.; The International System of Units NASA SP-7012, 1964, (Revised) 1972
2. Polhamus, Edward C.; Effect of Flow Incidence and Reynolds Number on Low-Speed Aerodynamic Characteristics of Several Noncircular Cylinders with Applications to Directional Stability and Spinning NASA TR R-29, 1959.



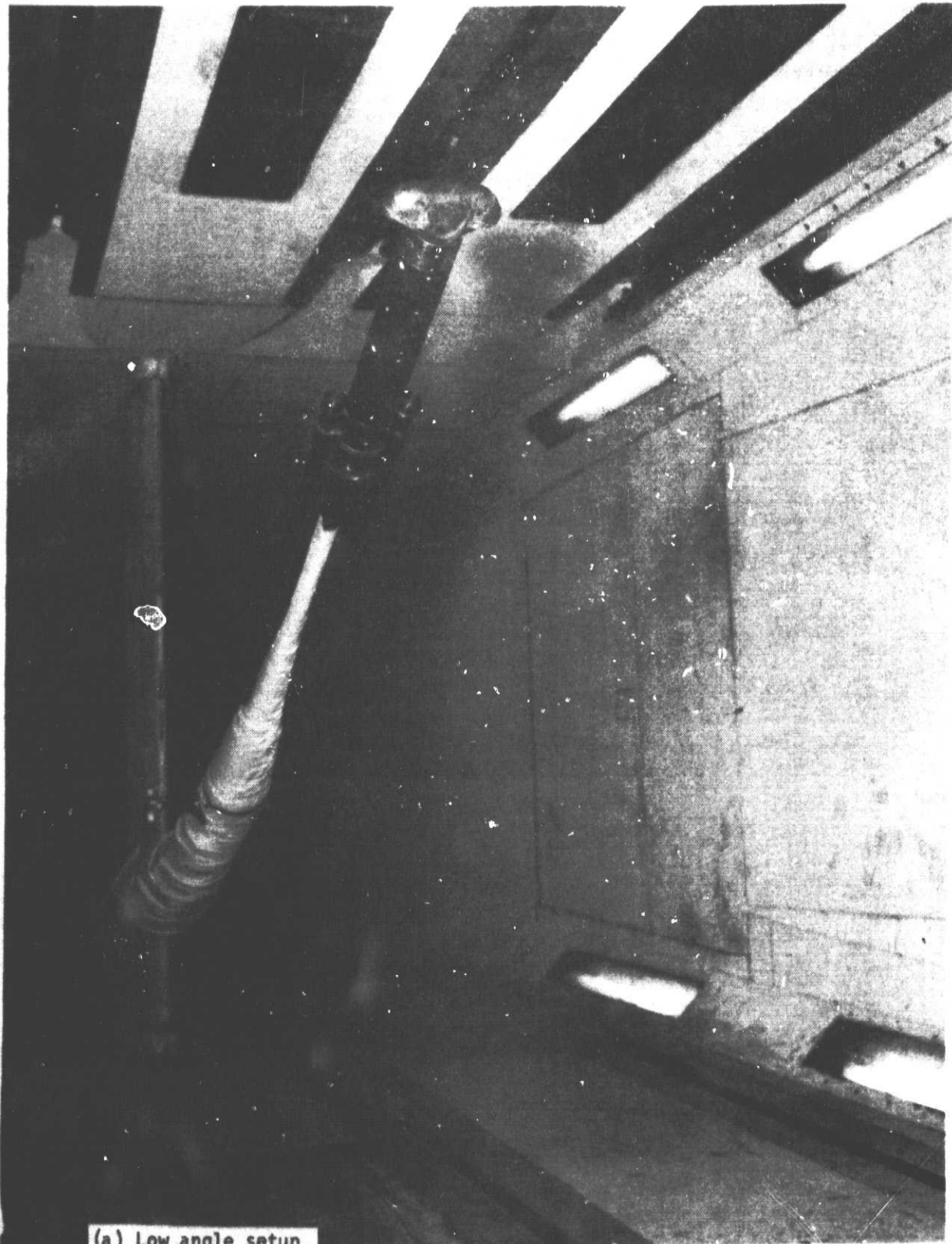
(a) Model geometry. All dimensions are based on the reference diameter of 7.620 cm. (3.000 in.)

Figure 1. Drawings of the model tested.



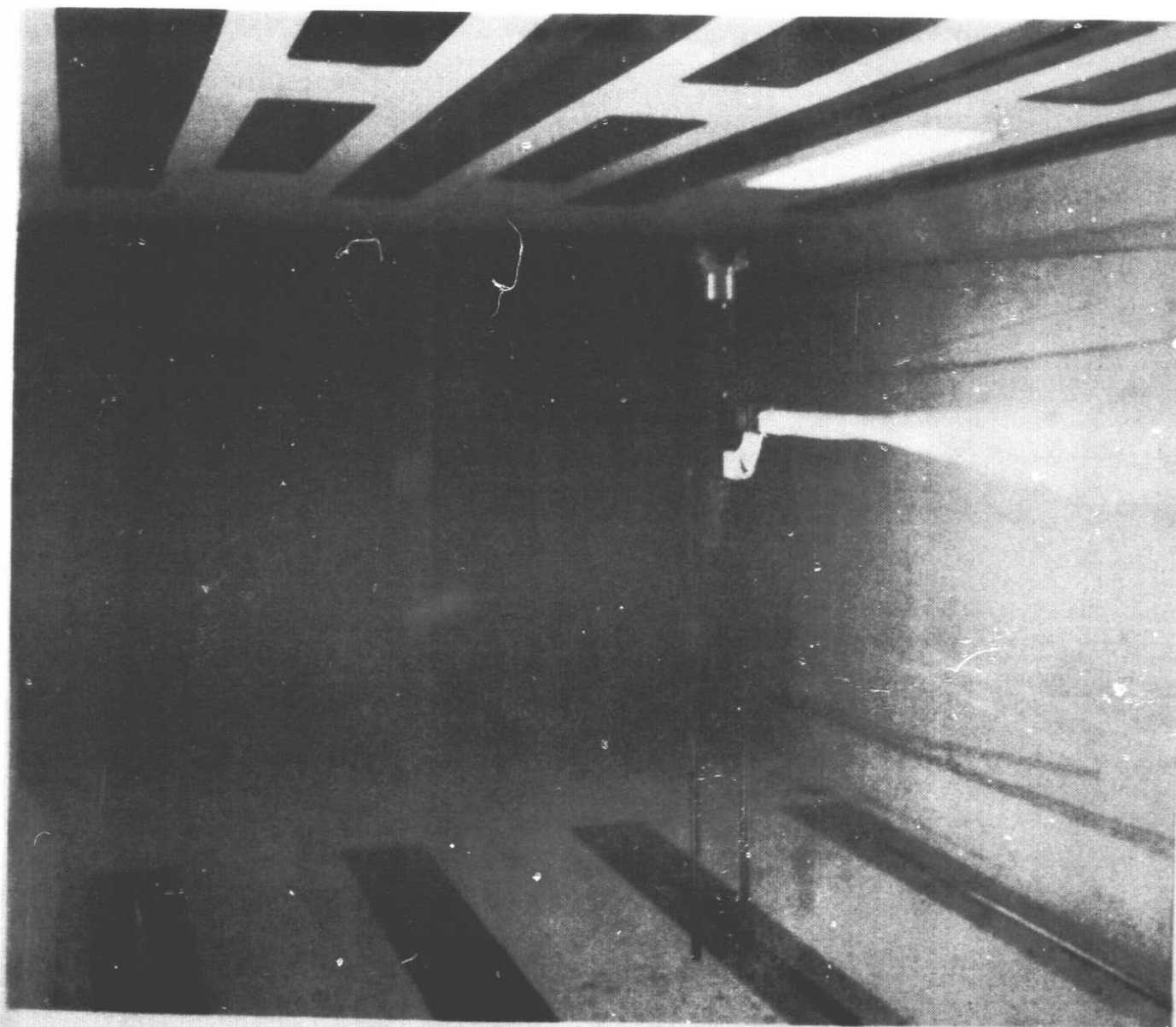
(b) Axis system for forces and moments.
Figure 1. Concluded.

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(a) Low angle setup.

Figure 2. Photographs of the model in the 7- by 10-foot high speed tunnel.



(b) High angle setup.
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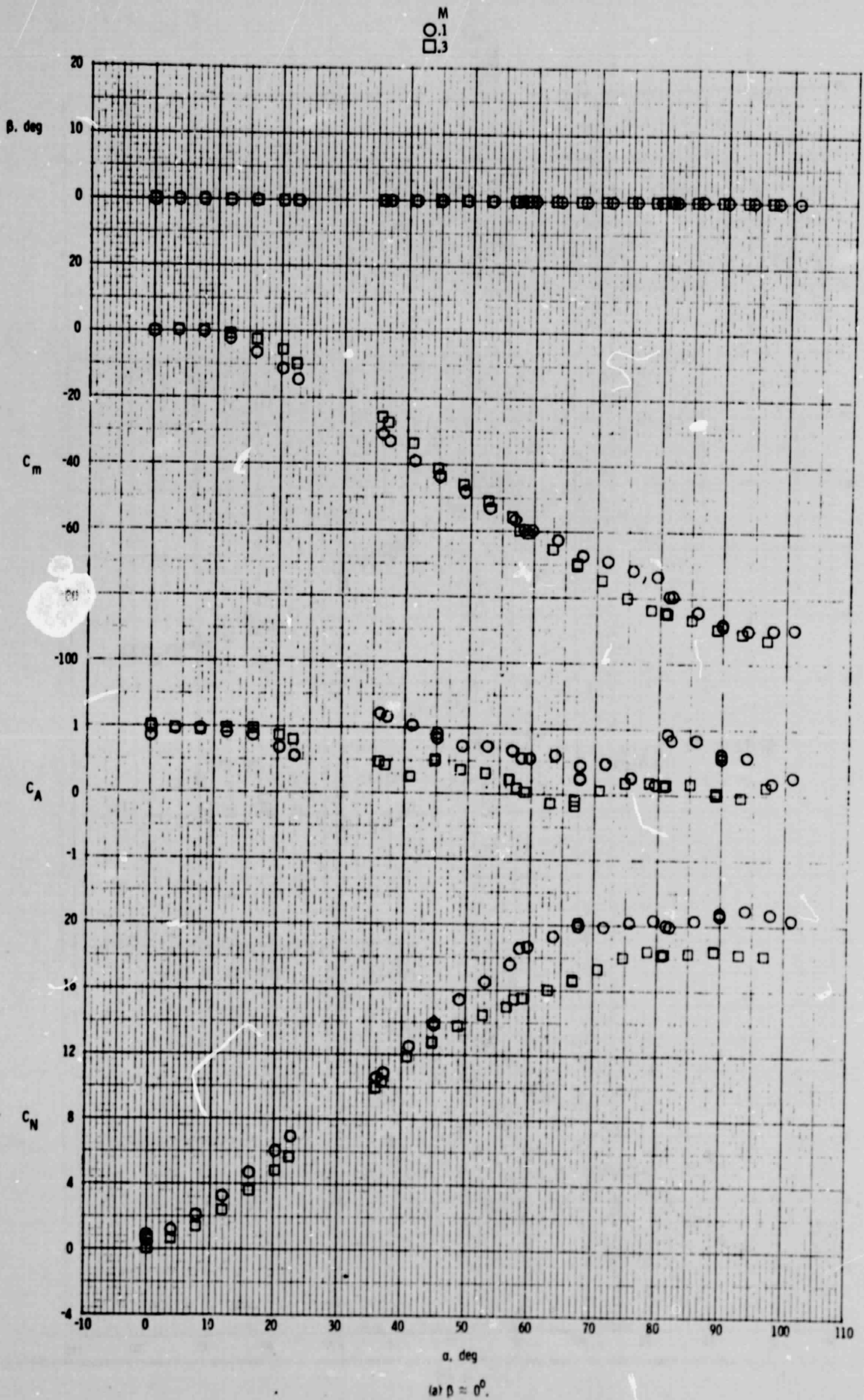


Figure 3- Longitudinal aerodynamic characteristics.

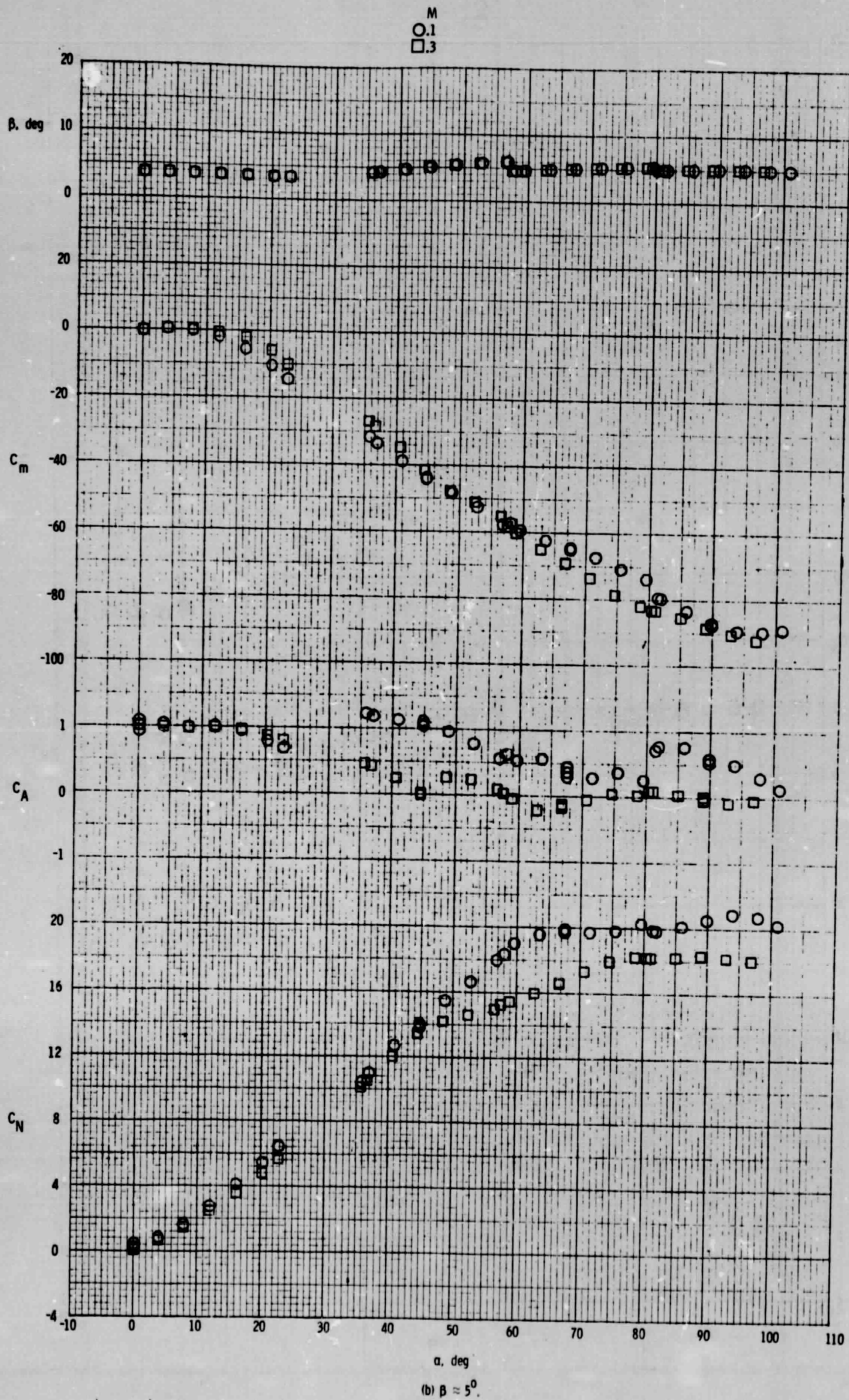
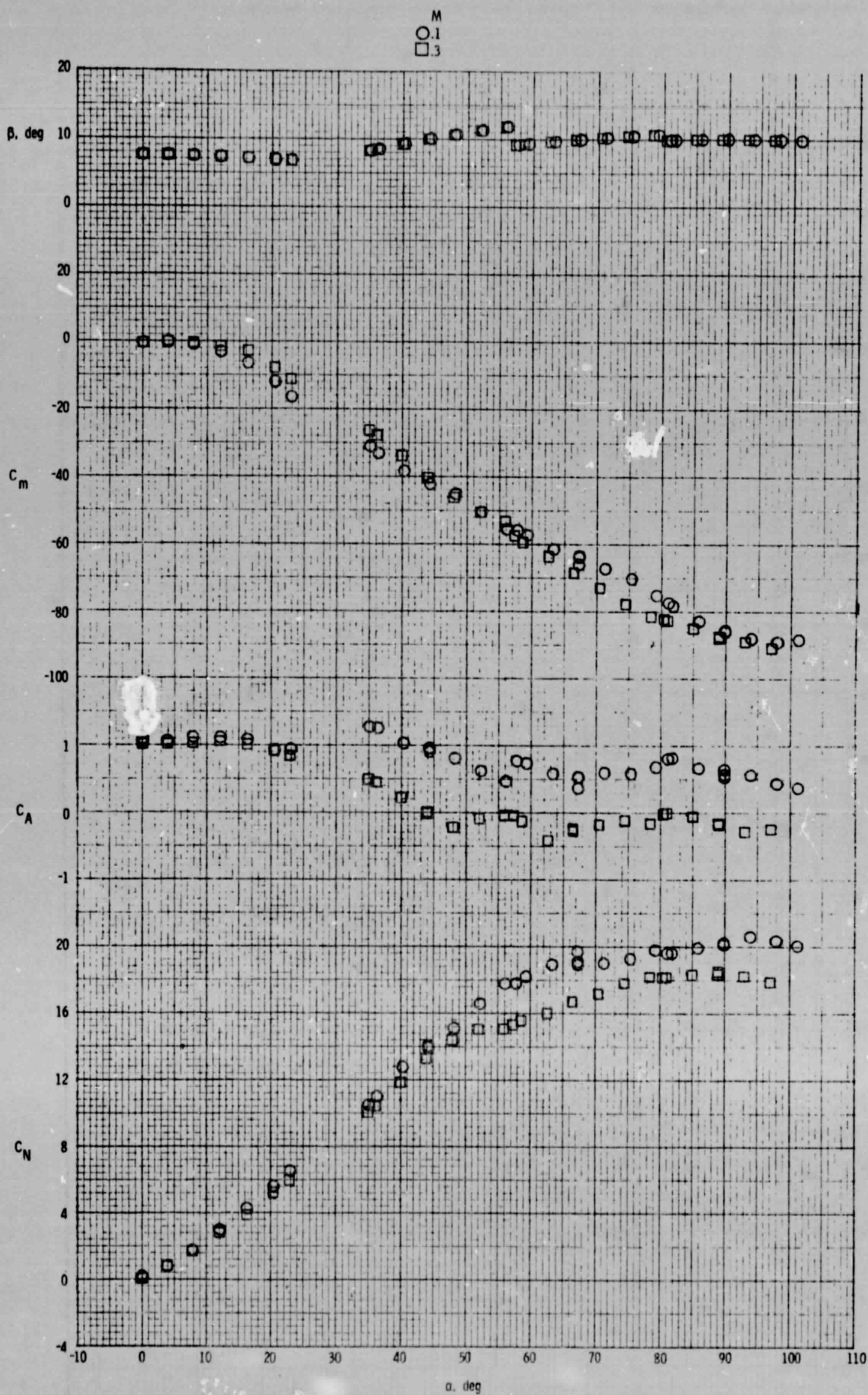
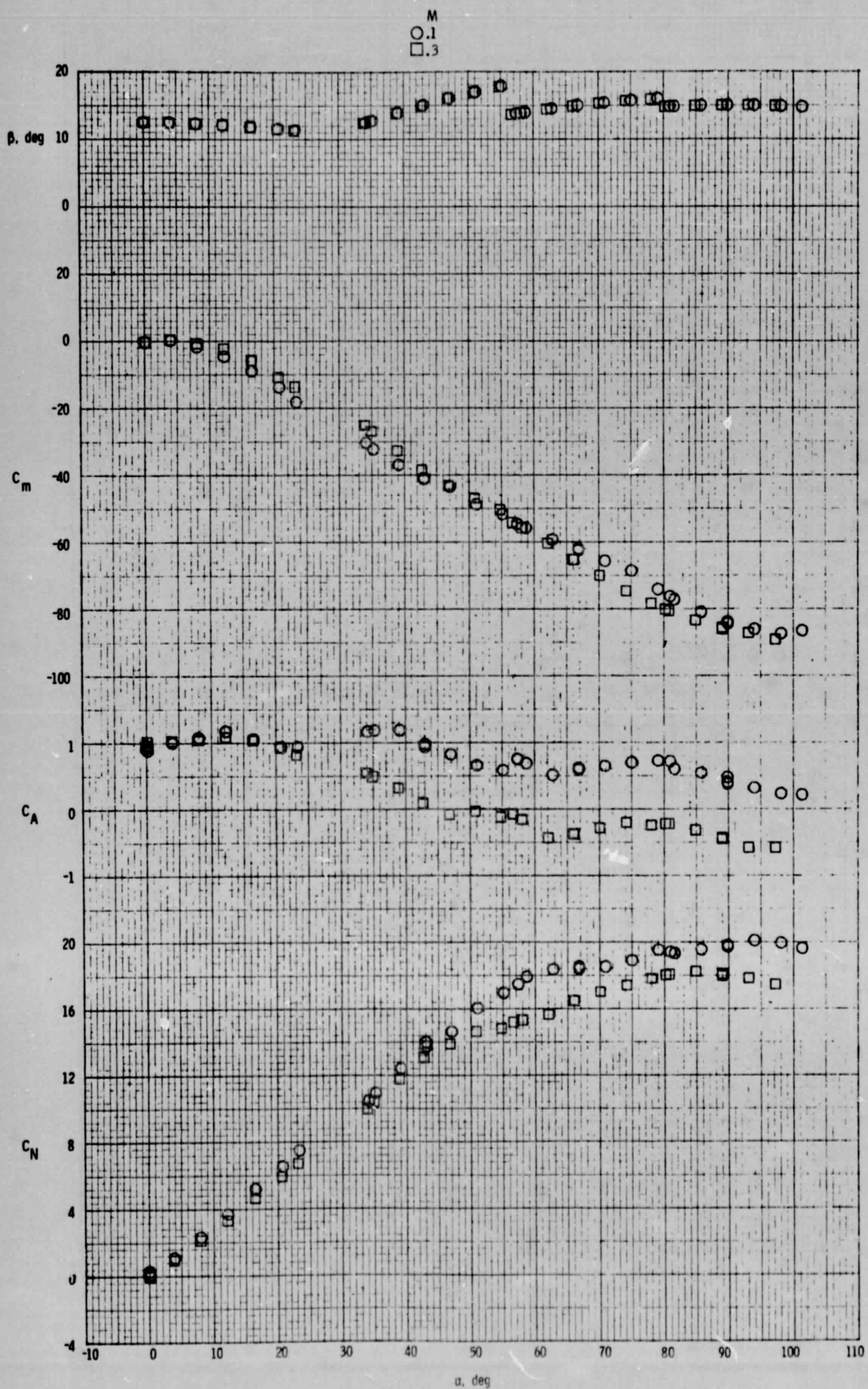


Figure 2- Continued.



(c) $\beta = 10^\circ$.

Figure 3- Continued.



(d) $\beta \approx 15^\circ$

Figure 3- Concluded.

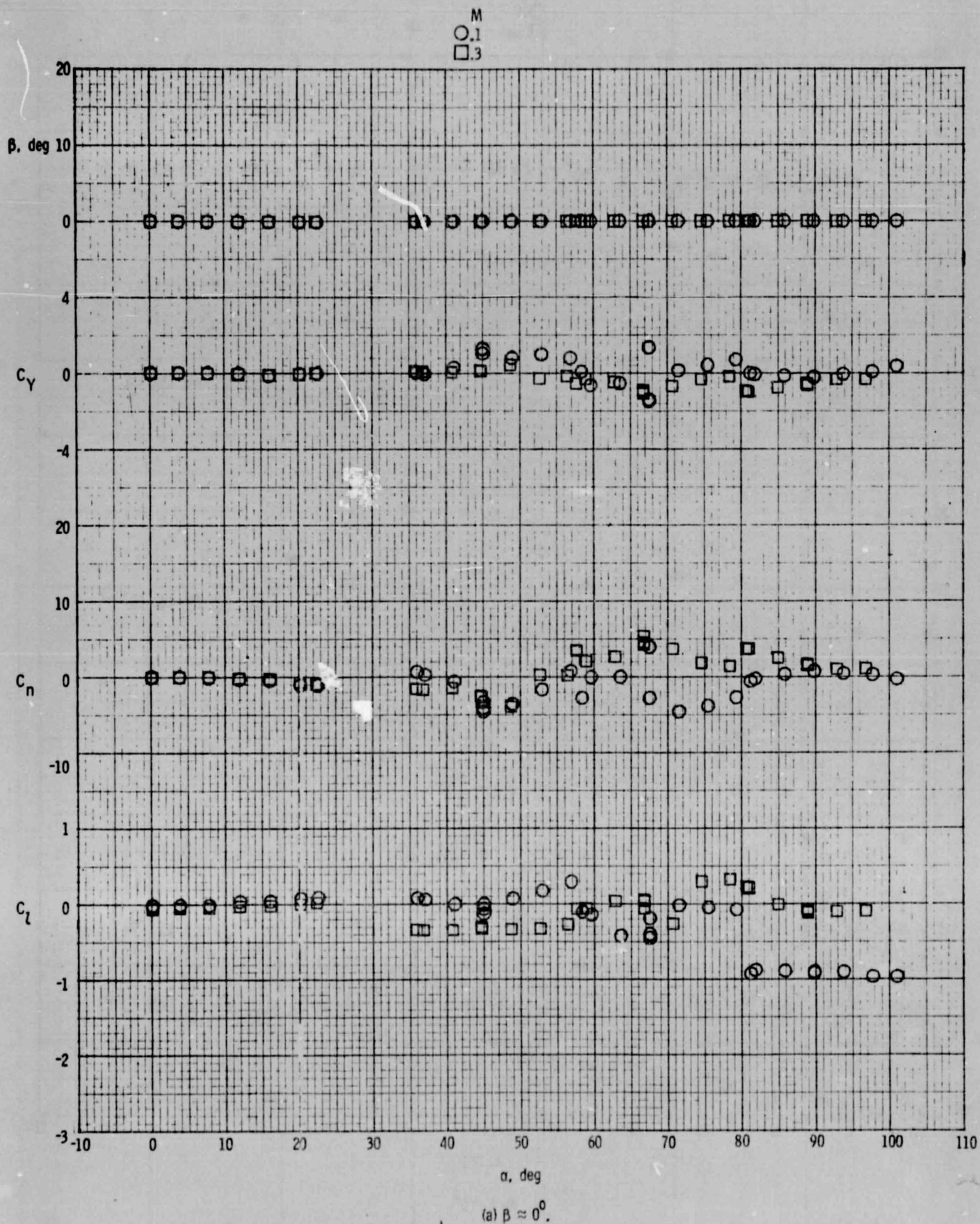
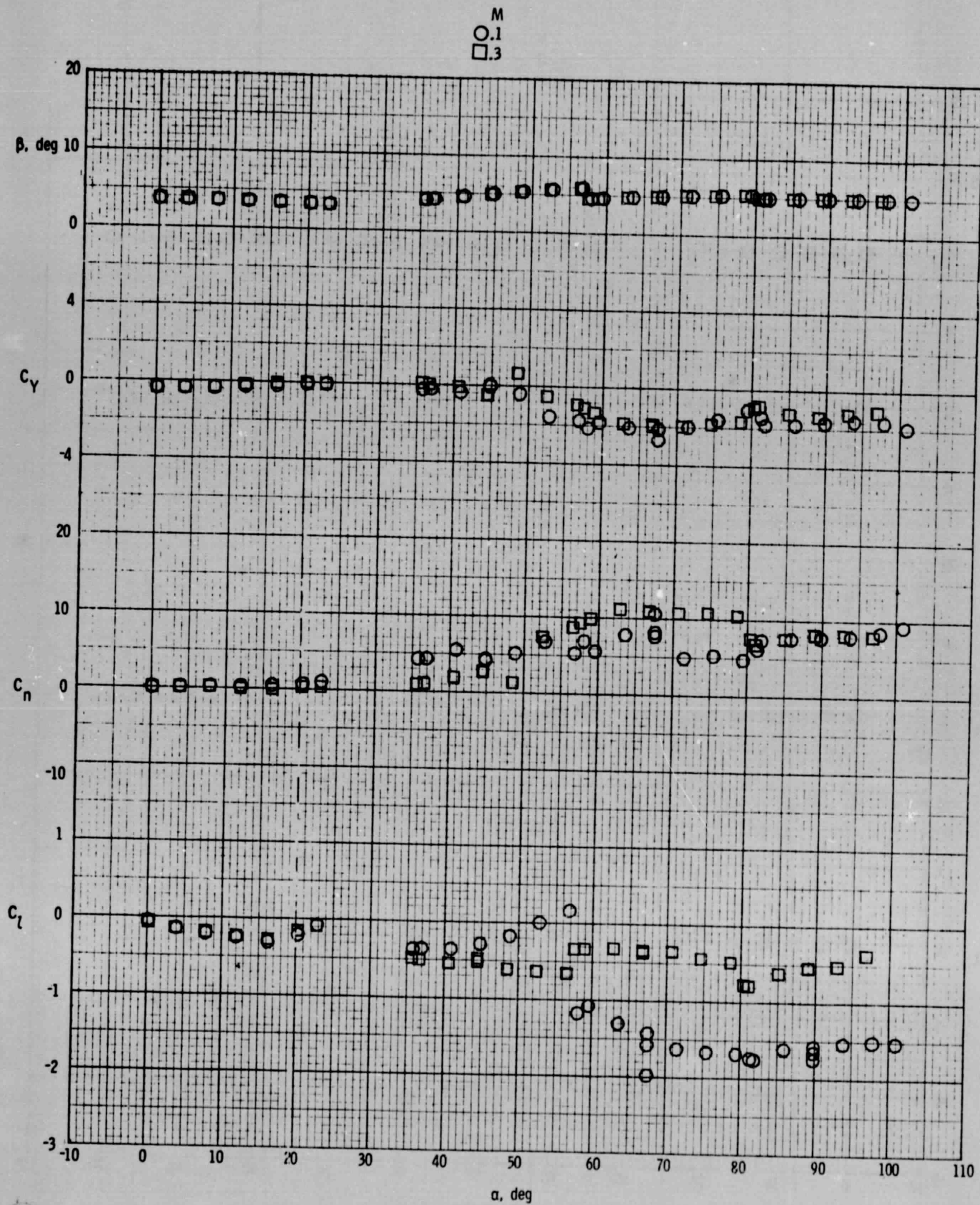


Figure 4- Lateral-directional aerodynamic characteristics.



(b) $\beta \approx 5^\circ$.

Figure 4- Continued.

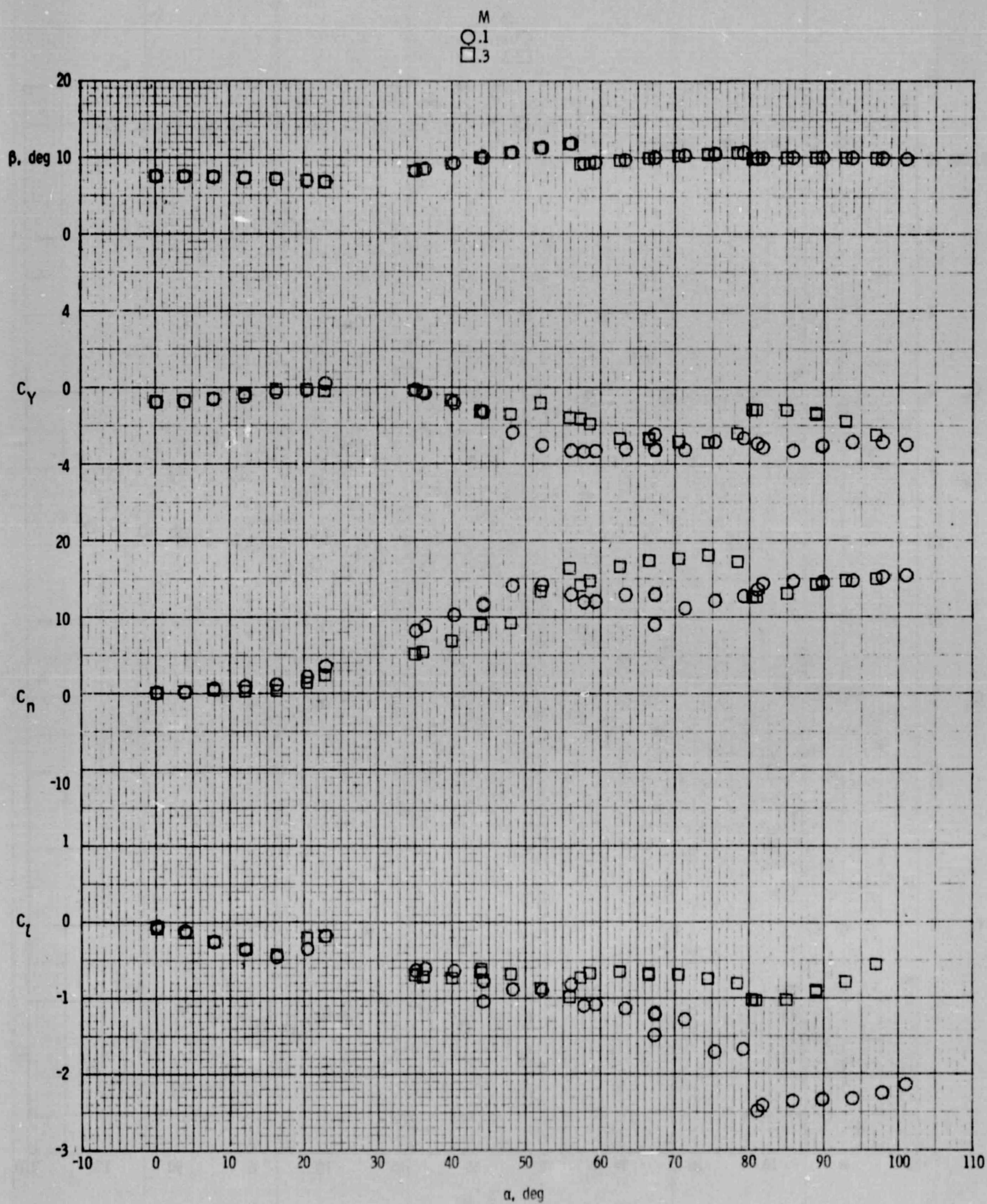
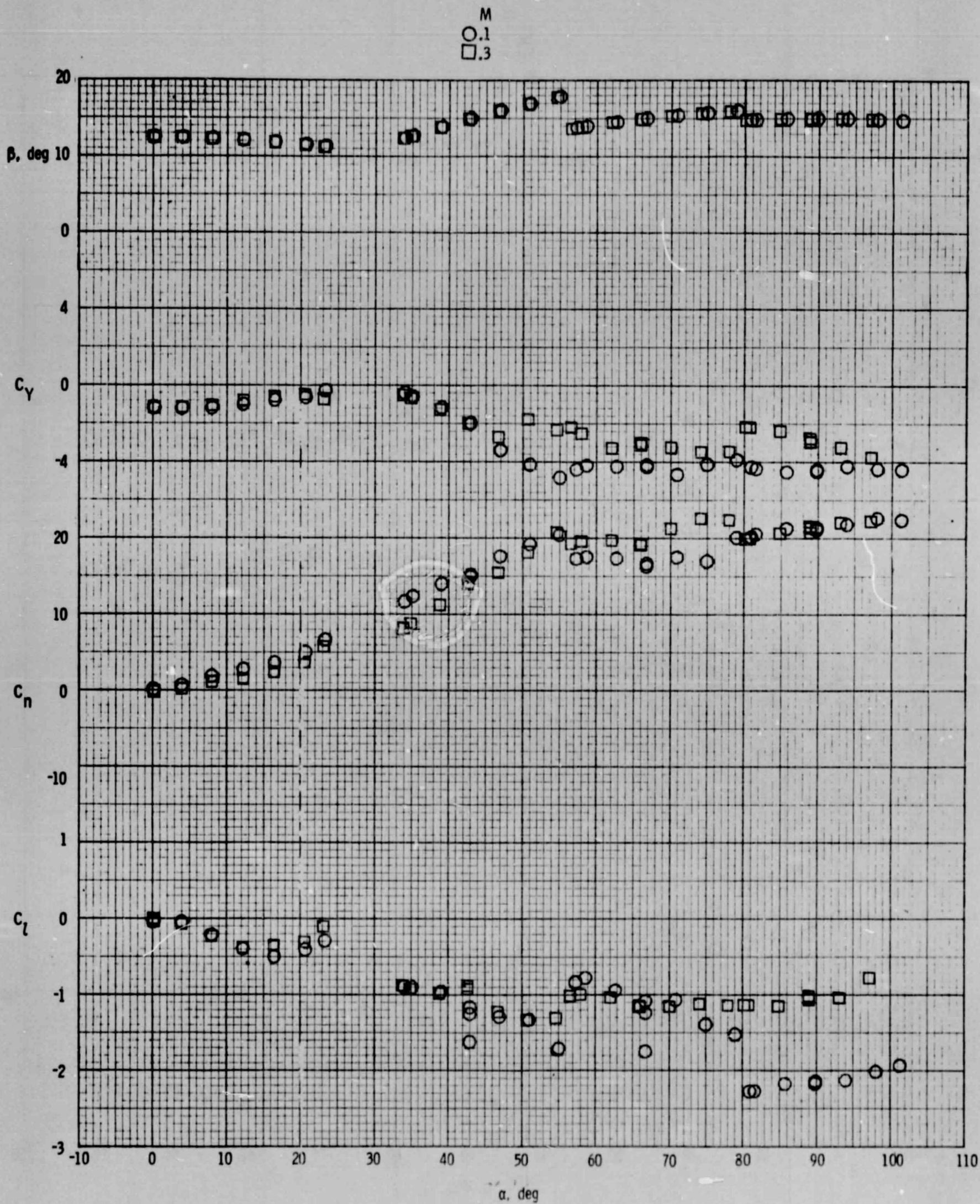


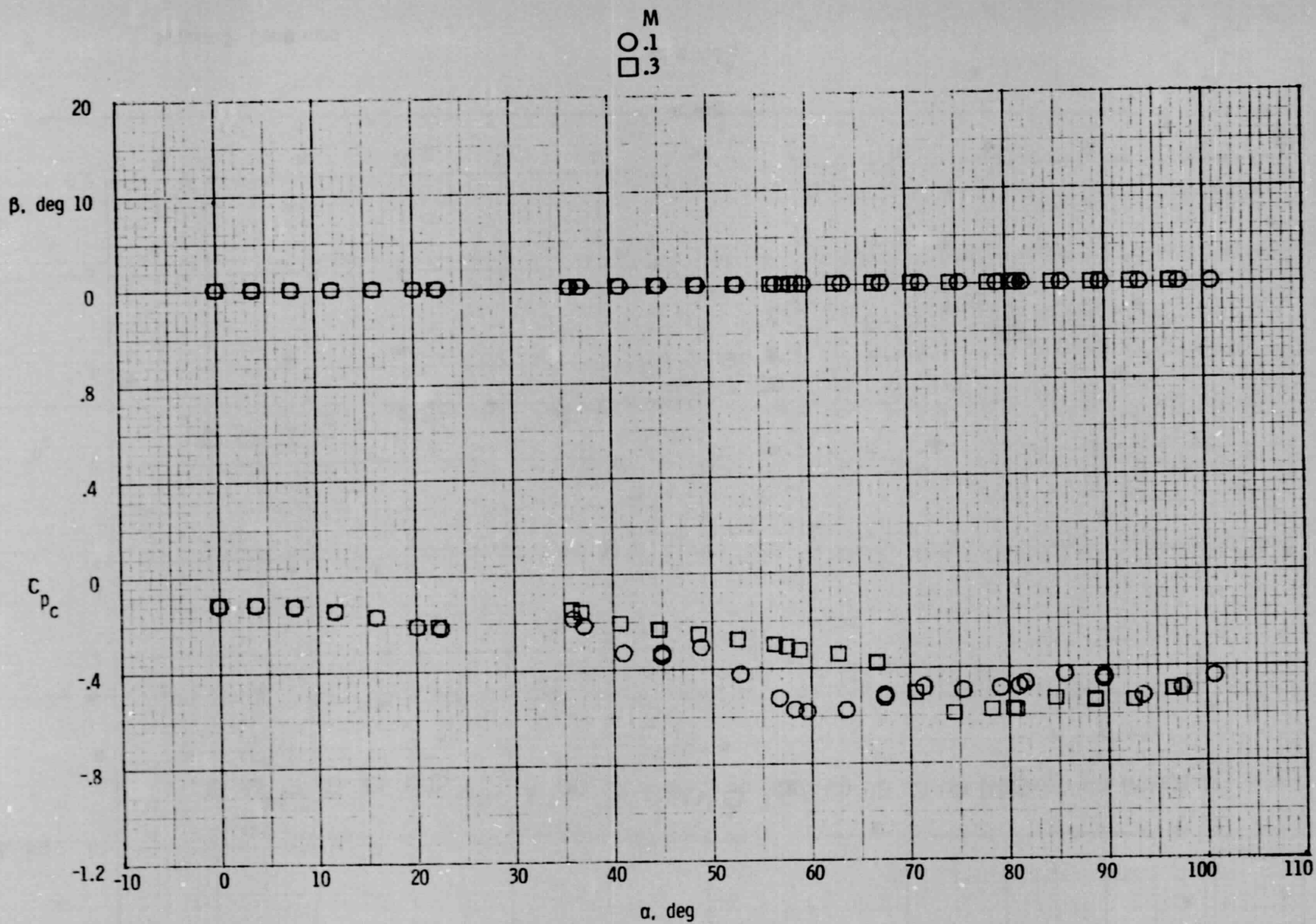
Figure 4- Continued.

(c) $\beta \approx 10^0$.



(d) $\beta \approx 15^\circ$.

Figure 4- Concluded.



(a) $\beta \approx 0^\circ$.

Figure 5- Chamber pressure characteristics.

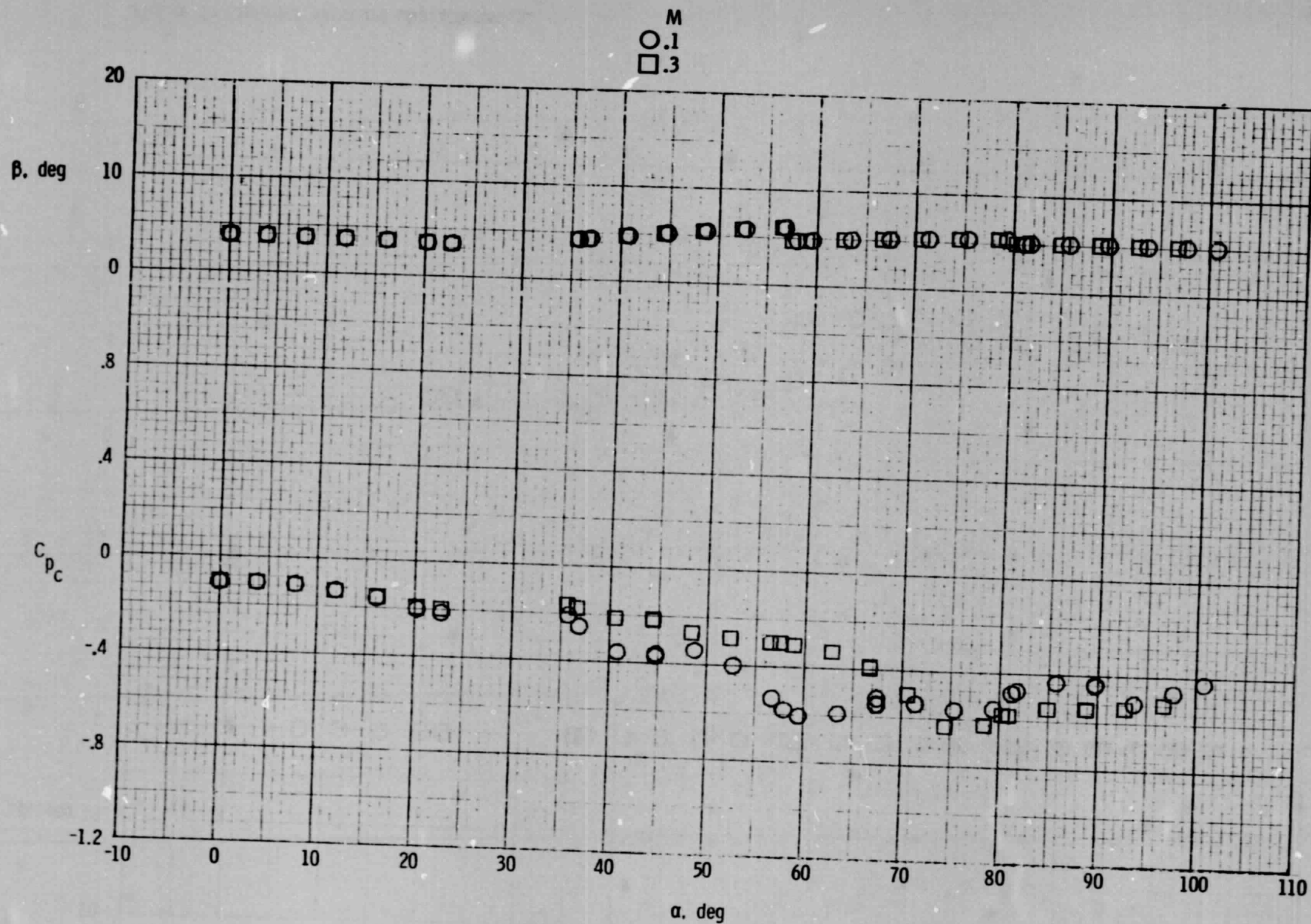
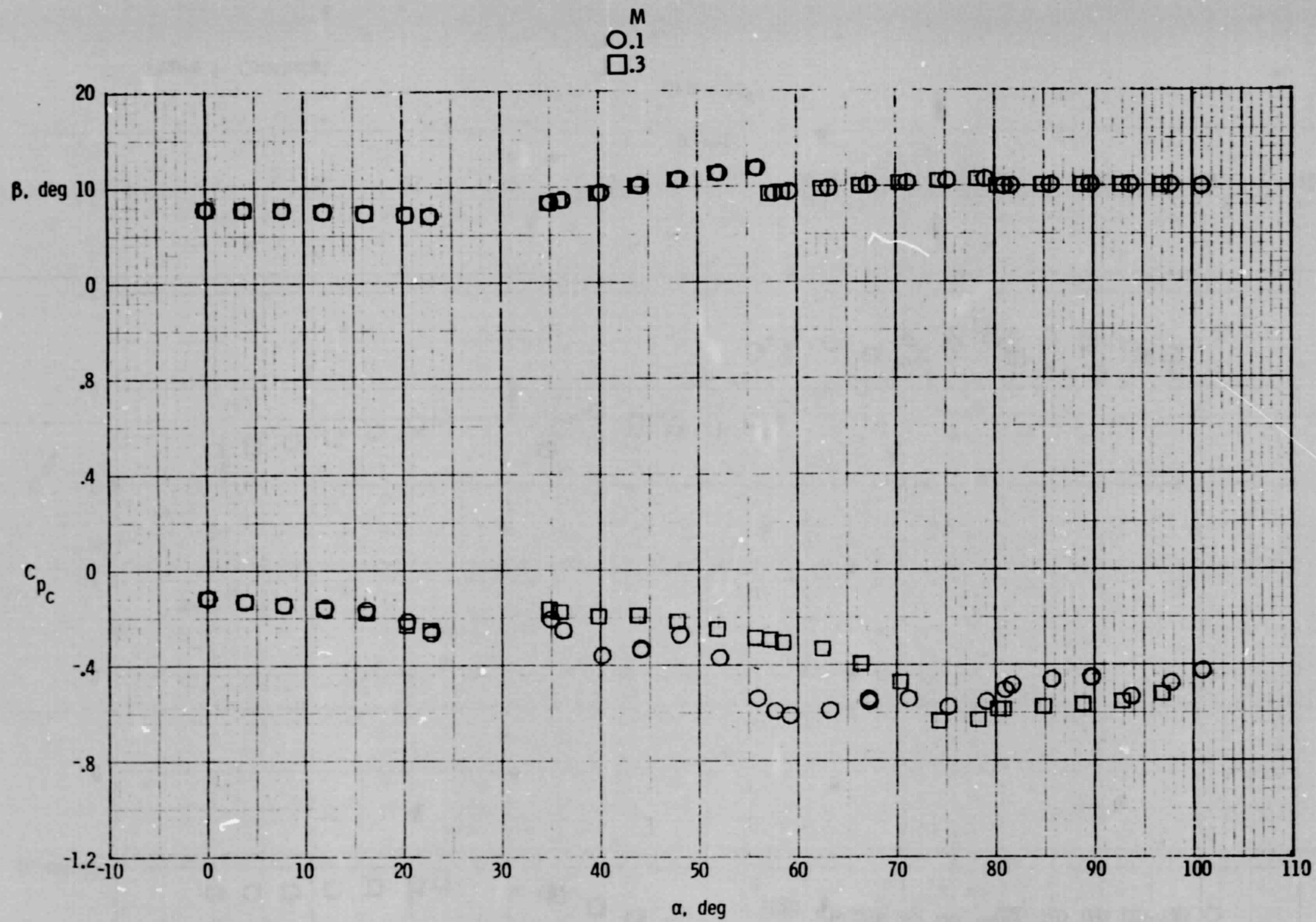


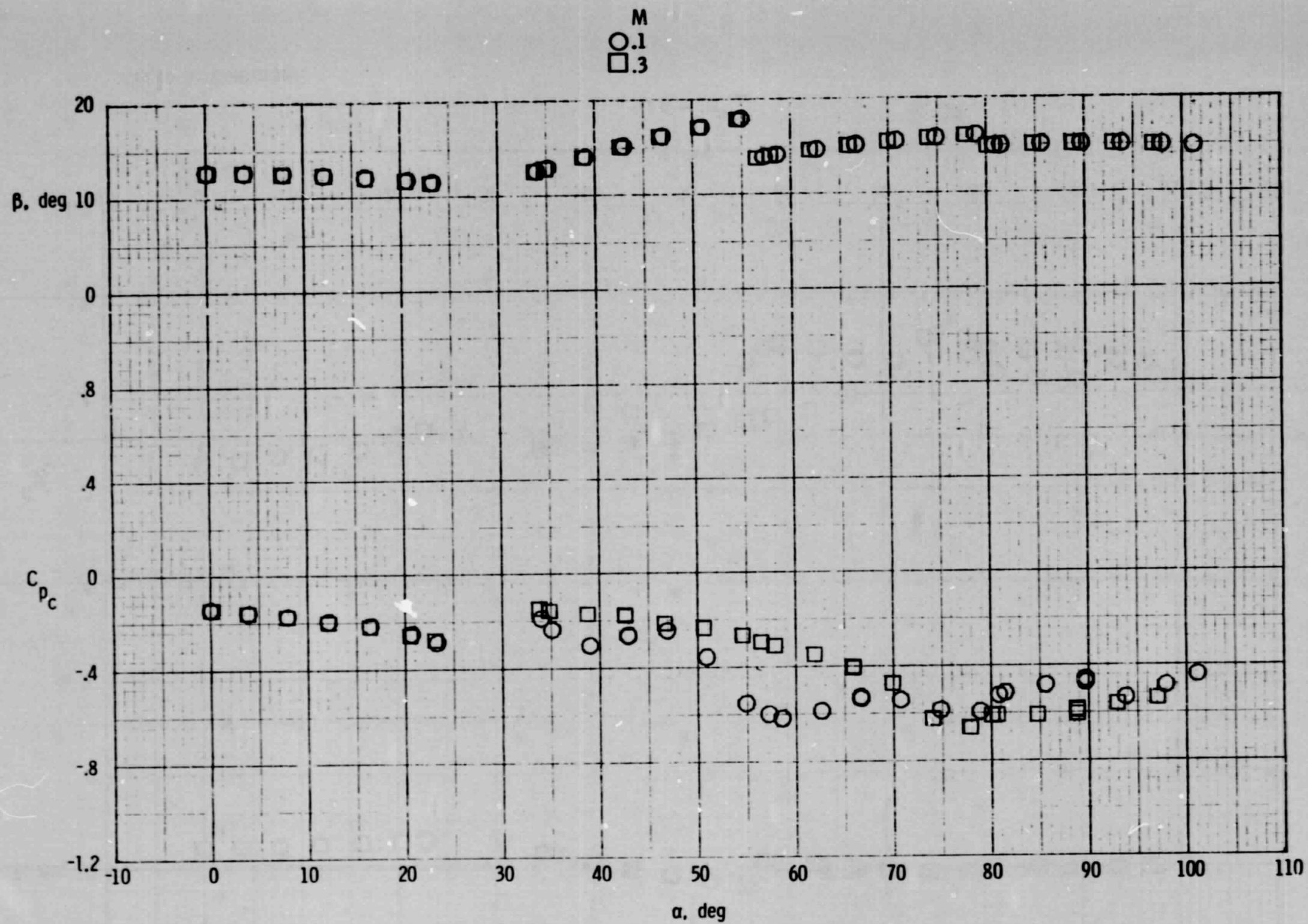
Figure 5- Continued.

(b) $\beta \approx 5^\circ$.



(c) $\beta \approx 10^0$.

Figure 5- Continued.



(d) $\beta \approx 15^\circ$.

Figure 5- Concluded.

1. Report No. NASA TM X-74012		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle LONGITUDINAL AND LATERAL-DIRECTIONAL STATIC AERODYNAMIC CHARACTERISTICS OF AN UNPOWERED ESCAPE SYSTEM EXTRACTION ROCKET MODEL WITH ATTACHED LAUNCH TUBES				5. Report Date May 1977	
				6. Performing Organization Code	
7. Author(s) Jarrett K. Huffman, Charles H. Fox, Jr. and Robert E. Satterthwaite				8. Performing Organization Report No.	
9. Performing Organization Name and Address Langley Research Center Hampton, VA 23665				10. Work Unit No.	
				11. Contract or Grant No.	
12. Sponsoring Agency Name and Address National Aeronautics & Space Administration Washington, DC 20546				13. Type of Report and Period Covered Technical Memorandum	
				14. Sponsoring Agency Code	
15. Supplementary Notes					
16. Abstract <p>An escape system extraction rocket proposed for use on the Rotor Systems Research Aircraft was tested at Mach numbers of 0.1 and 0.3 through an angle-of-attack range from -2° to 102° and an angle-of-sideslip range from 0° to 15° in the Langley 7- by 10-foot high speed tunnel. The data are presented without analysis in order to expedite publication.</p>					
17. Key Words (Suggested by Author(s)) Missiles Longitudinal aerodynamics Lateral-directional aerodynamics High angle of attack Subsonic flow Rockets			18. Distribution Statement Unlimited-Star Category-02 Unclassified		
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 23	22. Price* \$3.50		